Storage impact on IMPROVE filters for microbial communities

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IMPROVE Virtual Fall Steering Committee Meeting

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Contributions/coauthors, thank you!

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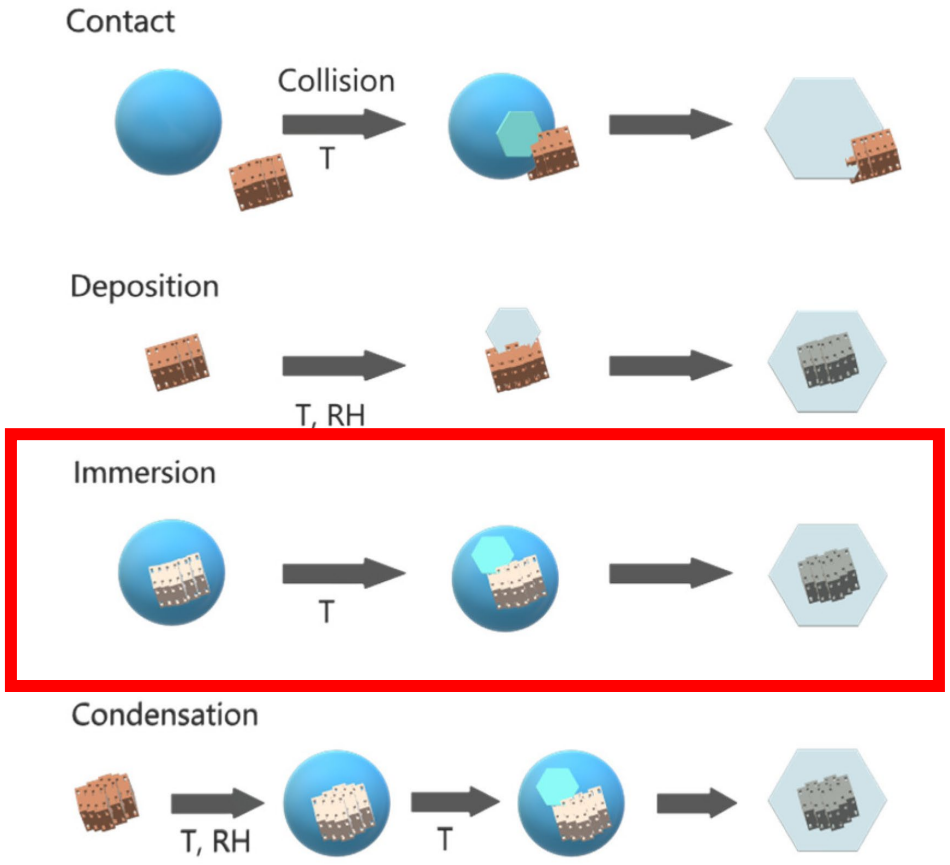
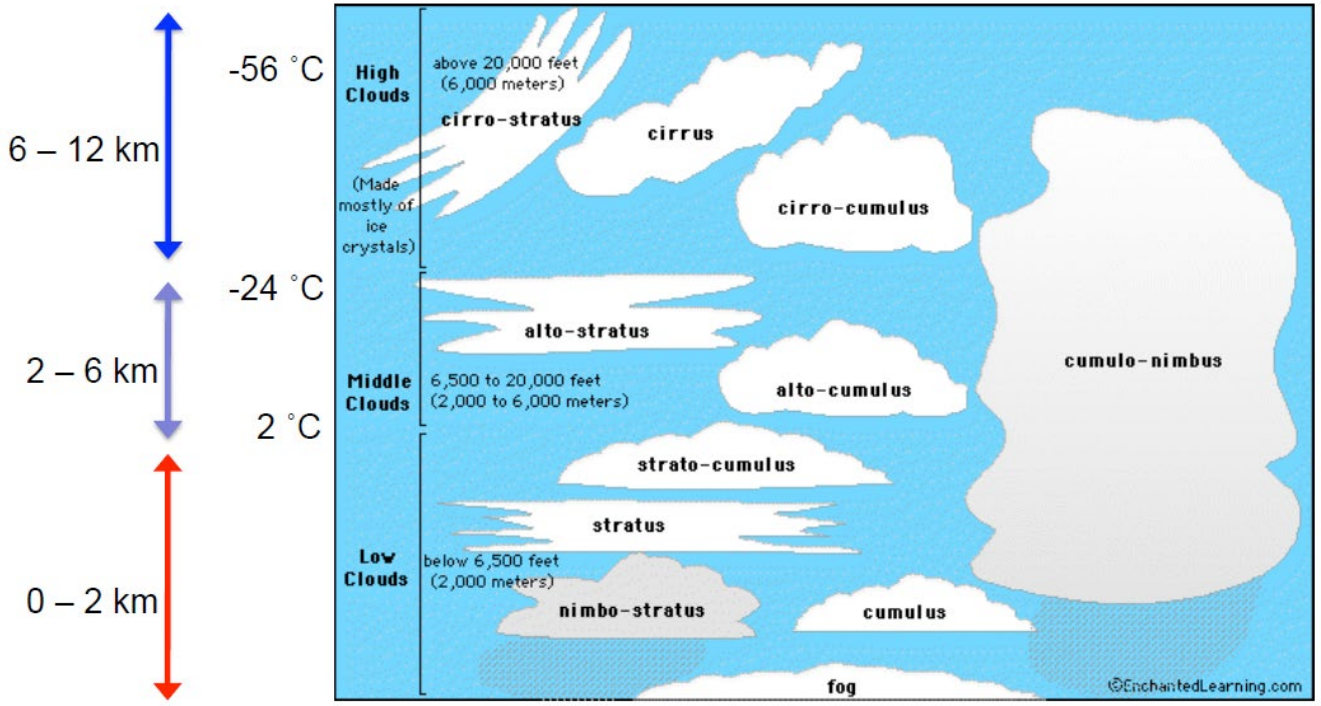
Project Motivation

- Little is known how storage conditions of aerosol filters affects their microbial composition and ice nucleating particle (INP) concentrations
- Module D/PM10 Module filters are used for total mass concentration and stored; available by request
- **Ties into goals of NSF BROADN: Goal 1:** sampling methods **Goal 2:** relationships between airborne microbes and terrestrial ecosystems

Ice nucleating particles (INPs) are needed to initiate ice formation warmer than homogeneous freezing (-38 °C)



Pach et al. 2021



Credit: Dr. Susan van den Heever

Biological ice nucleators

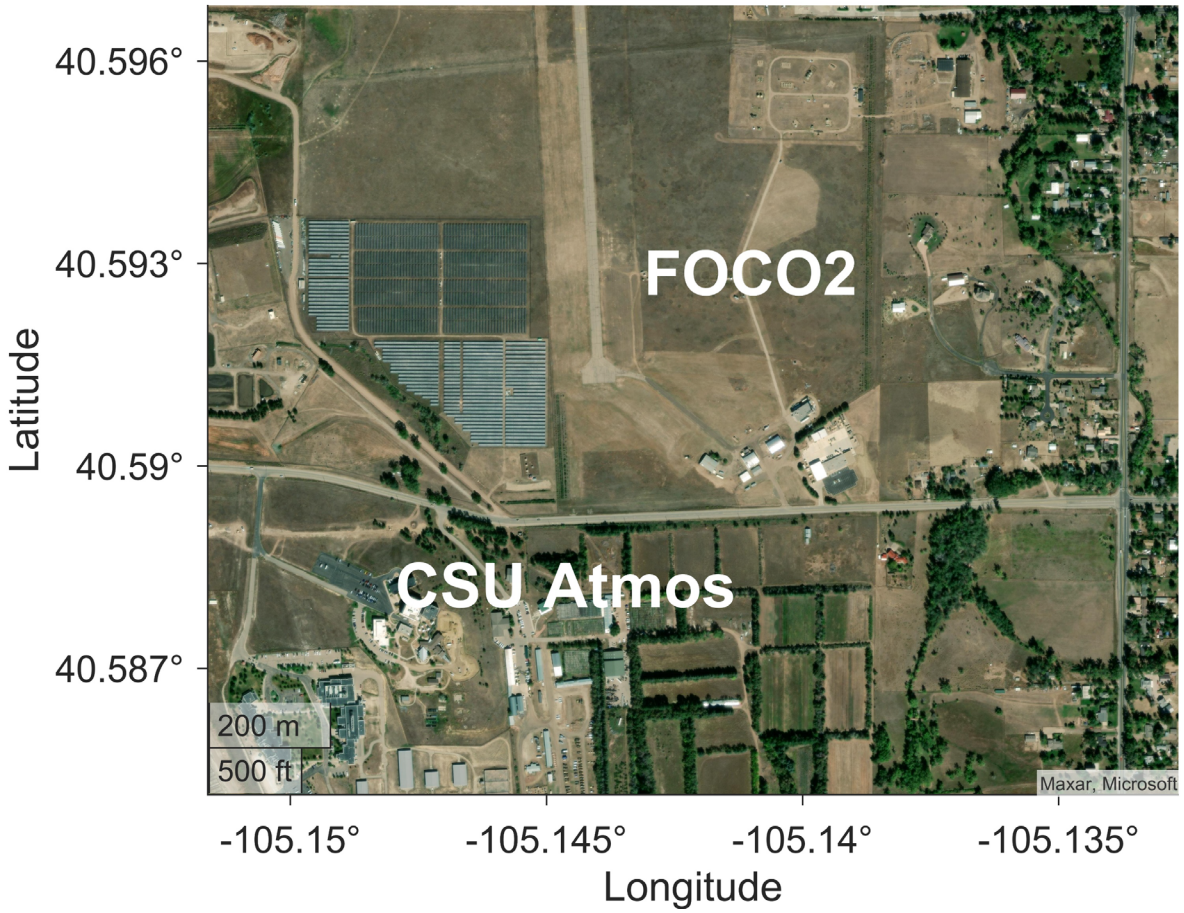
INPs have been found in lichen, plant tissues, fungi, pollen, unidentified organic INPs from many agricultural and arable soil dusts

Credit: Tom Hill

Hypothesis/Plan

- Hypothesis: Both heated and room temperature storage will affect INPs/microbial community composition
- Plan: Set up IMPROVE test site, composed solely of D Modules, and run them next to an established site

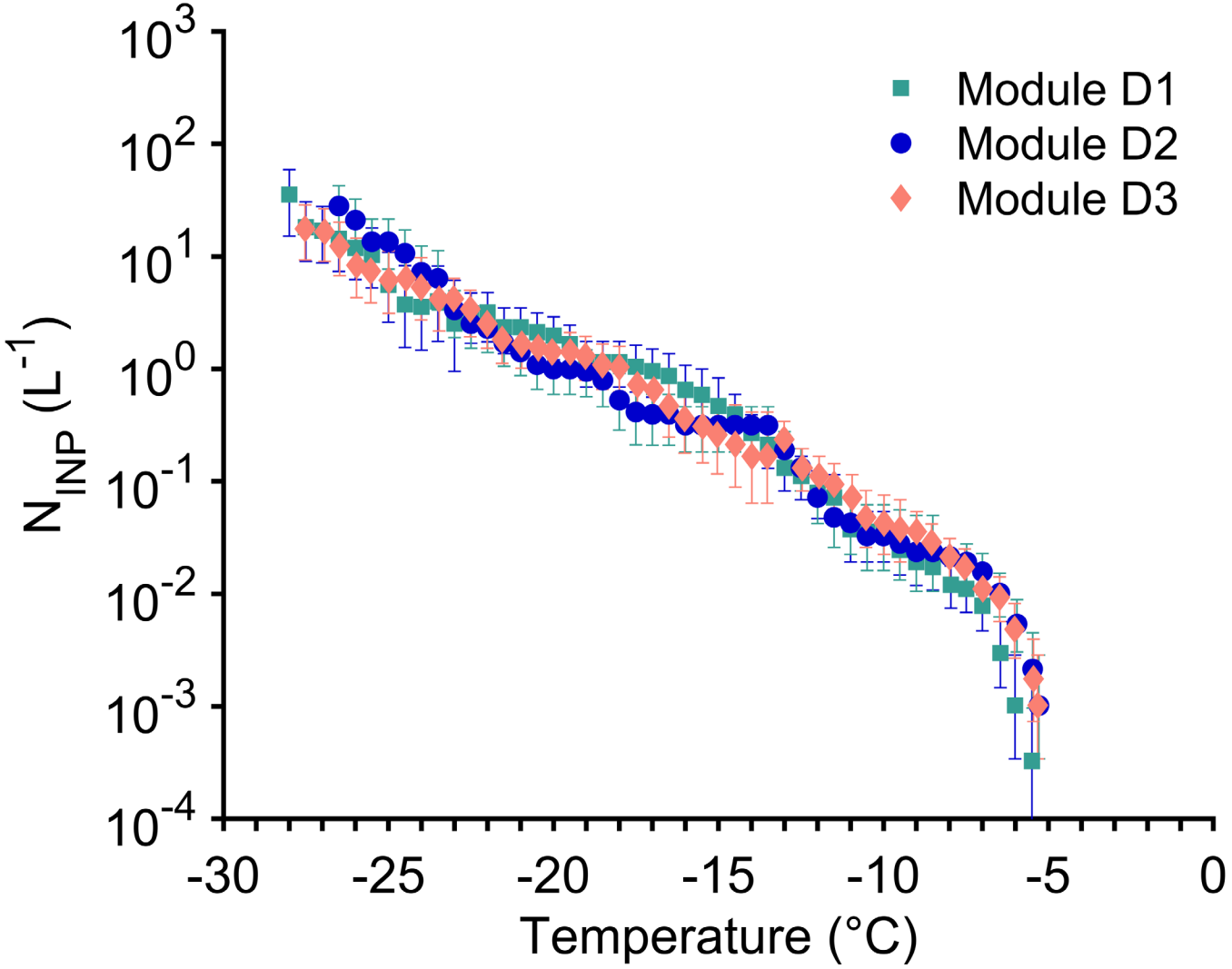
Plan/Approach



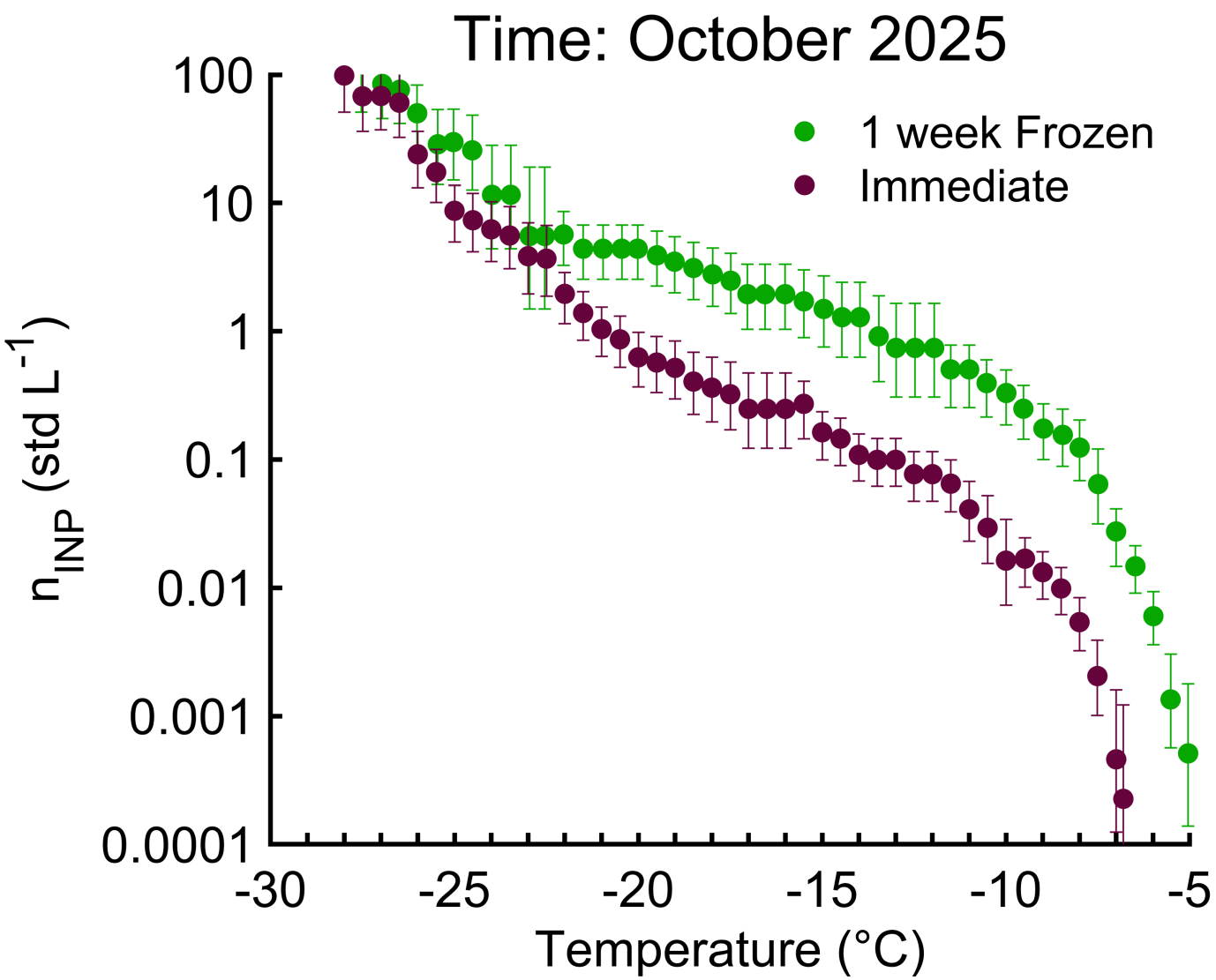
Sampling Goals/Approach

- Measure INPs and DNA looking at storage conditions:
  1) Room Temperature
  2) Frozen at -20 °C
  3) Heated in incubator at 40 °C to mimic summer storage
- 2 approaches
  1) Modules have time component but one treatment
  2) Modules have treatment component but one time
- Consistency with IMPROVE: 24-hour samples, 17 LPM, MTL Filters, 3.0 µm pore size

Initial testing showed comparability between modules



Meteorology added a confounding variable to tests



Separated by 3 days

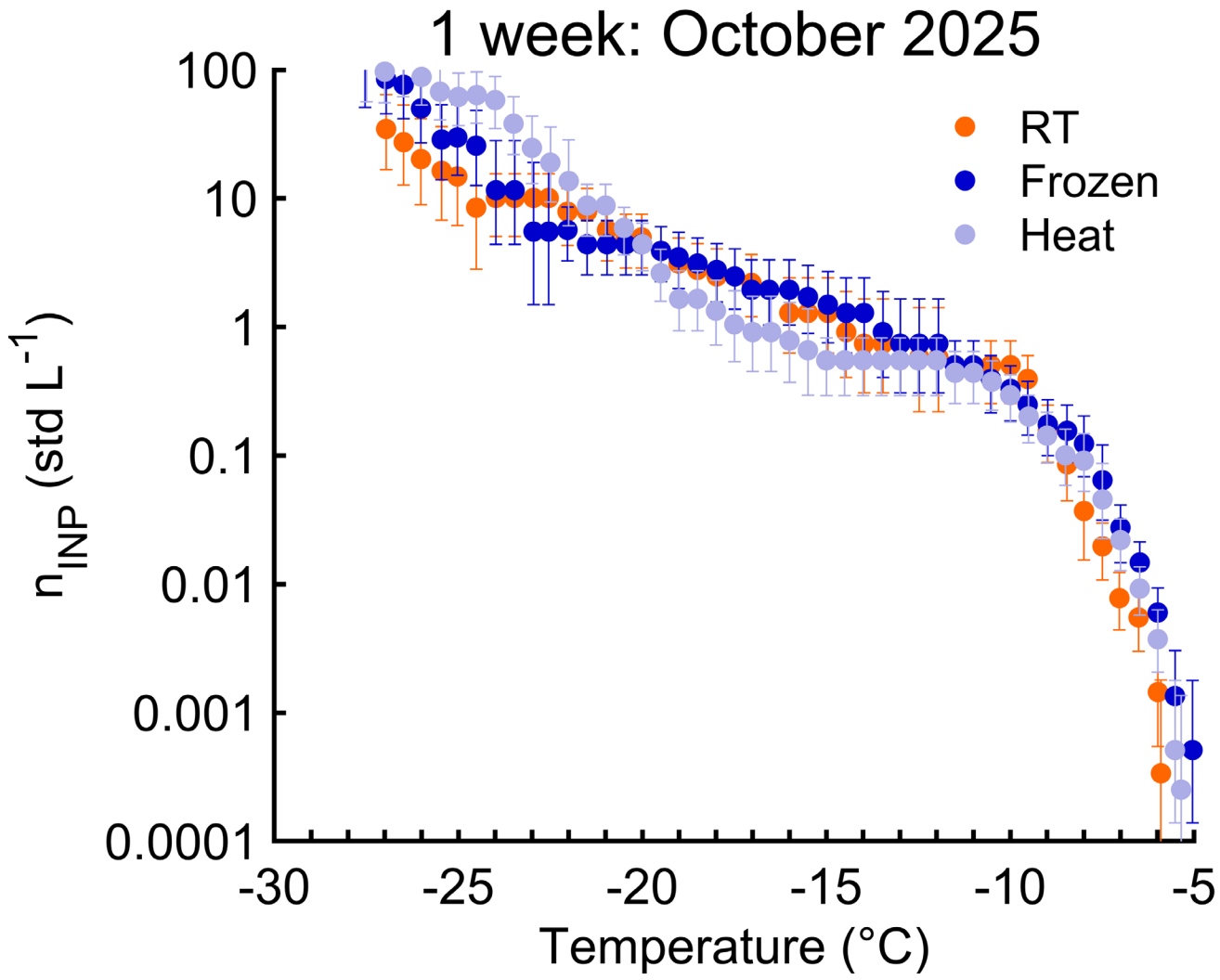
Example of Sampling Plan for Fall 2025

#	Test (start)	Filter 1	Filter 2	Filter 3
1	Monday Oct 13	INP RT 1 week	INP Frozen 1 week	INP Heat 1 week
2	Tuesday Oct 14	INP RT 1 month	INP Frozen 1 month	INP Heat 1 month
3	Wednesday Oct 15	INP RT 3 month	INP Frozen 3 month	INP Heat 3 month
4	Thursday Oct 16	INP RT Immed	INP Frozen 6 month	INP RT 6 month
5	Friday Oct 17	DNA RT 1 week	DNA Frozen 1 week	DNA Heat 1 week
6	Saturday Oct 18	DNA RT 1 month	DNA Frozen 1 month	DNA Heat 1 month
7	Sunday Oct 19	DNA RT Immed	DNA Frozen 6 month	DNA RT 6 month
8	Monday Oct 20	DNA RT 3 month	DNA Frozen 3 month	DNA Heat 3 month
	IMPROVE Sample			

Approximately 50 filters collected so far

- 25 in summer (July-August 2025)
- 24 in Fall Part 1 (October 2025)
- A few more filters will be collected this week (November 2025)

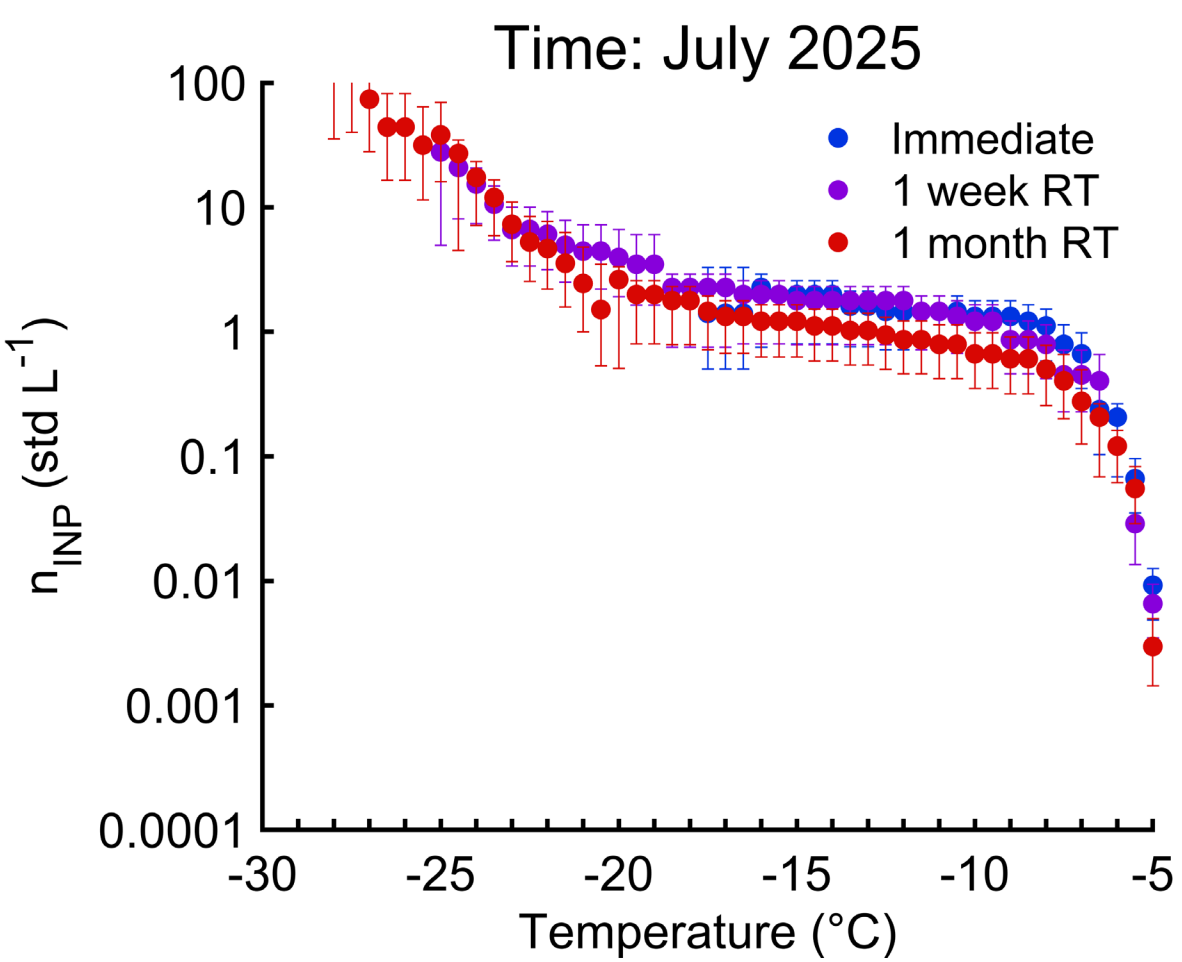
Similarities in INP and DNA concentration after 1 week

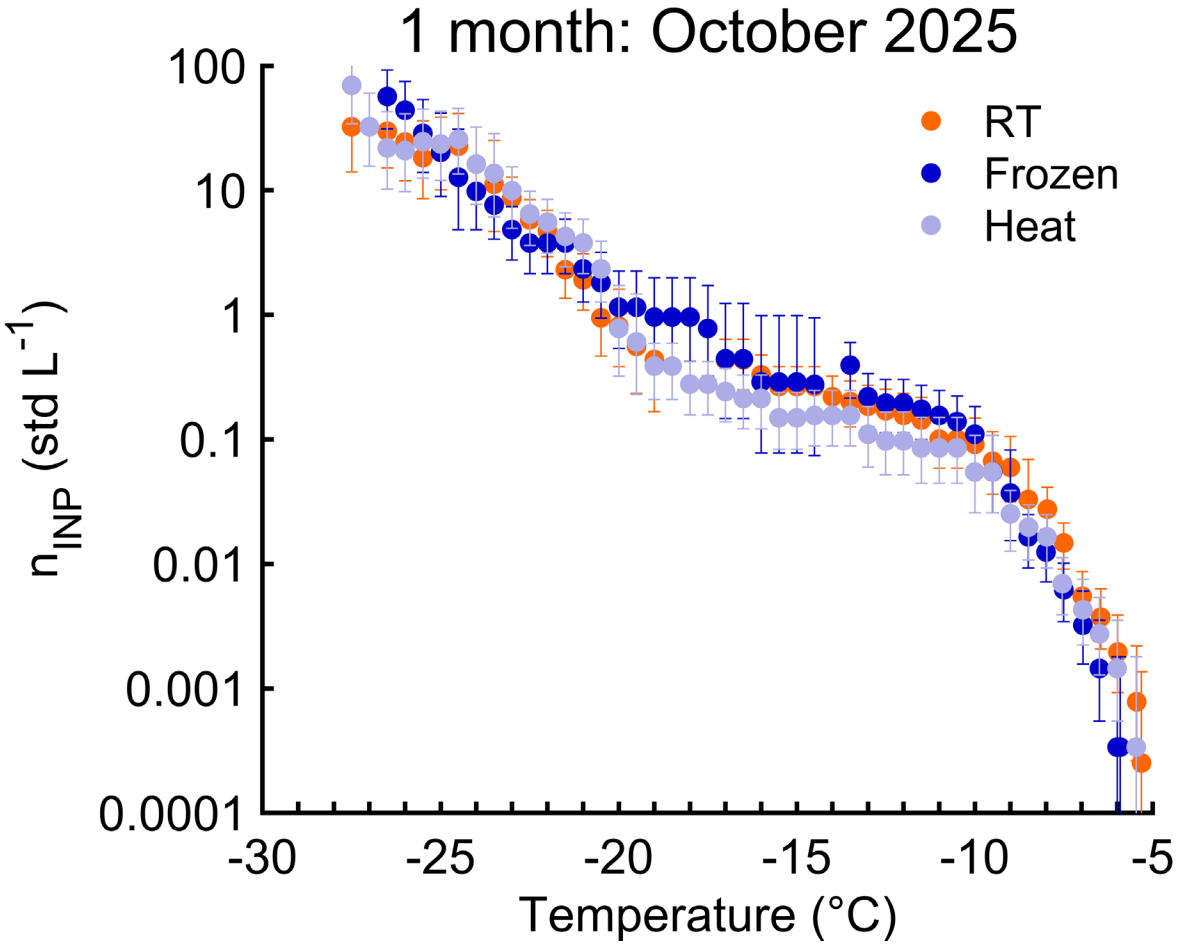


Total DNA Concentration

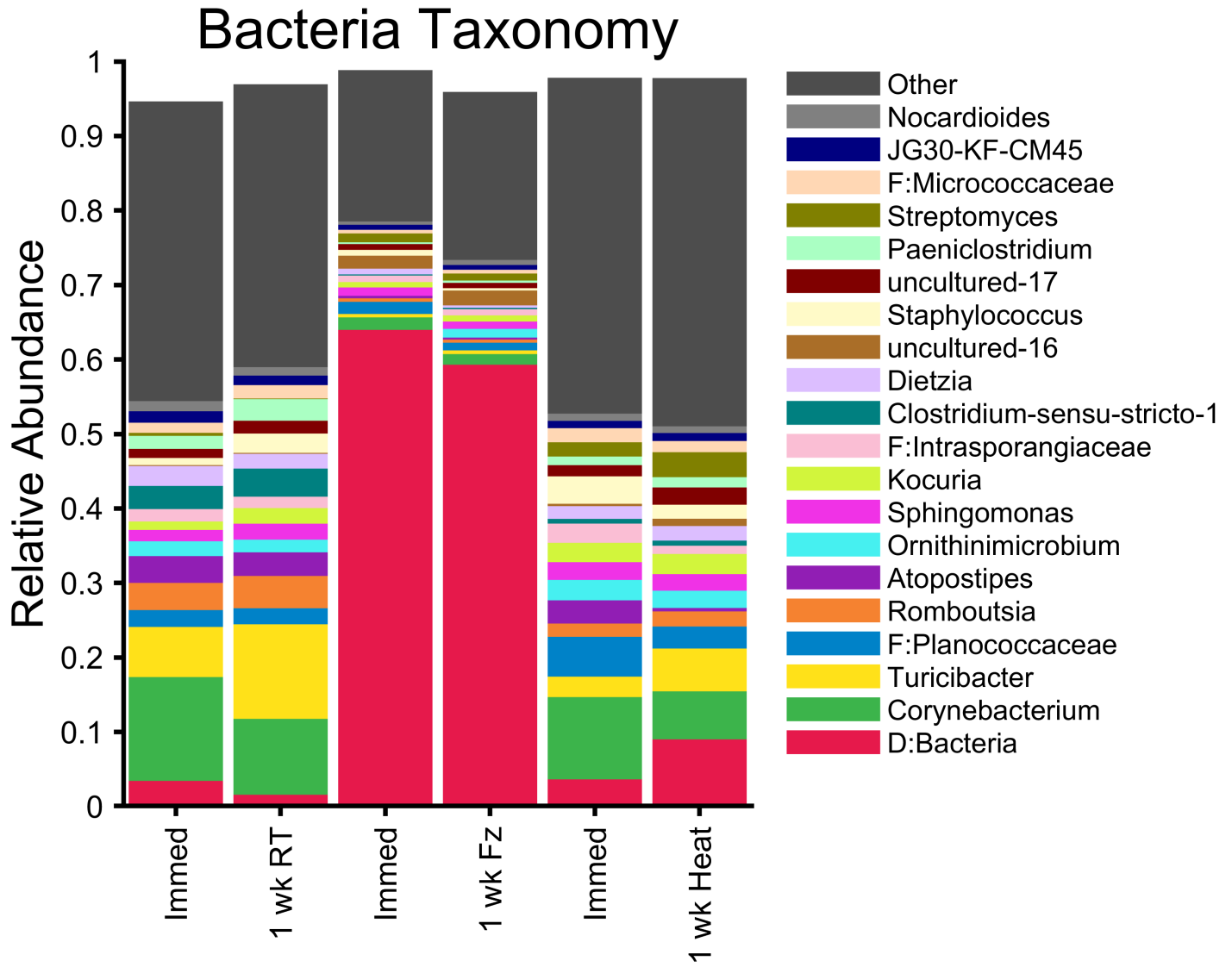
Treatment	ng/µL
RT 1 wk	0.094
Frozen 1 wk	0.0816
Heat 1 wk	0.063

Similarities in INP concentration after 1 month, slightly more degradation in summer?

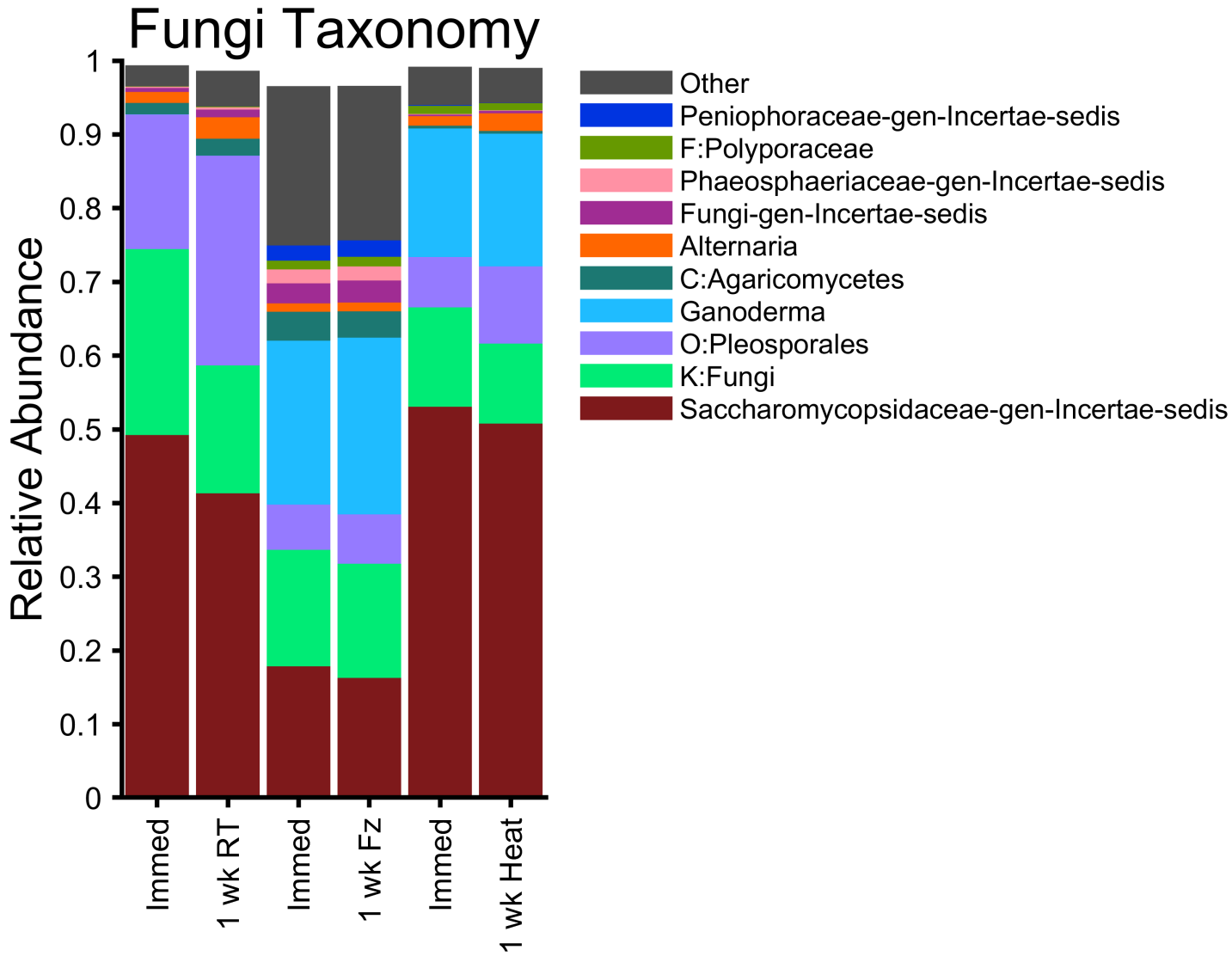




Similarities in Bacterial Taxonomy regardless of treatment on the order of 1 week



Similarities in Fungal Taxonomy regardless of treatment on the order of 1 week



Minor differences in ion data

	Chloride (ug/m^3) air	Nitrite (ug/m^3) air	Nitrate (ug/m^3) air	Sulfate (ug/m^3) air	Sodium (ug/m^3) air
Immed	0.01	0.04	0.54	0.85	0.06
RT1 wk	0.01	0.04	0.45	0.82	0.05
RT1 mo	0.02	0.03	0.23	0.50	0.08
RT24hrs	0.02	0.04	0.17	0.50	0.03
Frozen 24 hrs	0.02	0.04	0.15	0.45	0.02
Heat 24 hrs	0.07	0.04	0.16	0.44	0.02
RT1 wk	0.02	0.04	0.16	0.44	0.03
Frozen 1 wk	0.03	0.04	0.16	0.42	0.03
Heat 1 wk	0.03	0.04	0.15	0.40	0.03
	Ammonium (ug/m^3) air	Potassium (ug/m^3) air	Magnesium (ug/m^3) air	Calcium (ug/m^3) air	
Immed	0.32	0.06	0.04	0.28	
RT1 wk	0.28	0.05	0.03	0.24	
RT1 mo	0.16	0.05	0.03	0.22	
RT24hrs	0.19	0.06	0.04	0.19	
Frozen 24 hrs	0.18	0.06	0.03	0.18	
Heat 24 hrs	0.18	0.06	0.03	0.17	
RT1 wk	0.14	0.10	0.04	0.43	
Frozen 1 wk	0.14	0.11	0.04	0.50	
Heat 1 wk	0.13	0.10	0.03	0.44	

Minor differences in ion data

	Chloride (ug/L)	Nitrite (ug/L)	Nitrate (ug/L)	Sulfate (ug/L)	Sodium (ug/L)	Ammonium (ug/L)	Potassium (ug/L)	Magnesium (ug/L)	Calcium (ug/L)
RT 1 mo	36	94	1697	760	81	490	127	75	946
Frz 1 mo	42	99	1710	755	40	487	125	66	993
Heat 1 mo	26	97	1420	742	33	403	115	65	947

Conclusions thus far

- Aerosols collected with the IMPROVE Module D/PM 10 Module show promise for bioaerosol and INP work
  - Consistency on the order of 1 month in summer and fall
  - Similar concentrations as well as taxonomy for both bacteria and fungi

Future work

- Finish sampling (November 2025)
- Finish analyses at dedicated time points
- Another batch of microbial sequencing:
  - Testing long-range ITS and 16S sequencing to give more resolution for both fungi and bacteria

Acknowledgements

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BII Award 2120117